State of Wisconsin/Department of Transportation

RESEARCH PROGRESS REPORT FOR THE QUARTER ENDING: June 30, 2008

Program: SPR-0010(36) FFY99	**Part: II Research and Development**
Project Title: Development of a Database Framework and Implementation Plan for Integrating WisDOT Materials and Construction Databases	**Project ID:** 0092-08-17
Administrative Contact: Nikki Hatch	**Sponsor:**
WisDOT Technical Contact: Jim McDonnell	**Approved Starting Date:** 11/29/07
Approved by COR/Steering Committee: $79,994.05	**Original End Date:** 2/28/09
Project Investigator (agency & contact): Kelly L. Smith	**Current End Date:** 2/28/09
	Number of Extensions: 0

Percent Complete: 25%

Request a No Cost Time Extension (Please Select One): ☐ **YES** ☑ **NO**

Reason for No Cost Time Extension:

Project Description: Following are the research tasks:

Task 1—Interview Researchers
Task 2—Review WisDOT Databases and Determine Database Linkage Needs
Task 3—Identify and Map Logical Relationships in Databases
Task 4—Identify Database Integration Constraints
Task 5—Suggest Revisions and Evaluate Methods for Linking Databases
Task 6—Prioritize Database Integration Recommendations
Task 7—Prepare Final Report and Technical Design Document

Progress This Quarter:
(Includes project committee mtgs, work plan status, contract status, significant progress, etc.)

This quarterly report covers the work performed between April 1, 2008 and June 30, 2008. During this time, work has been primarily focused on Task 2. Summaries of the progress and notable results of each task are provided below.

Task 1—Interview Researchers

Additional feedback on issues related to WisDOT databases was obtained from Dr. Jim Crovetti with Marquette University. Referring to one of his recent (2003-2005 timeframe) WHRP projects, Dr. Crovetti noted using the Materials Tracking System for establishing mix design parameters and incurring some challenges in determining project ID numbers for existing pavement sections. Approximately 50 percent additional effort was required for that particular activity, which resulted in some delay of the subsequent work activities. Dr. Crovetti suggested one improvement that could be made in the area of database integration is to have an interactive highway map that can be used to select pavement sections to obtain a listing of associated project ID numbers.

Task 2—Review WisDOT Databases and Determine Database Linkage Needs

The project team coordinated through WHRP and WisDOT to review pavement materials and performance databases as part of task 2 of the project. The databases reviewed (May 15, 2008) were as follows:

1. Materials and Construction
   - HMA Mix Design Database
   - Materials Tracking and Reporting Systems (MTS).
2. Performance and Pavement Management

- Pavement Information Files (PIF)
- Layer & Base
- NewCon Reports
- Office All
- PMDSS

3. Location/Spatial Referencing
   - Location Control Management (LCM)

Discussions and demonstrations for databases in item 1 were held with Ms. Judith Ryan and Tom Brokaw. All databases listed in item 2 were discussed with Mr. Michael Melaney and Ms. Laura Fenley. Details of the LCM listed in item 3 were provided by J.J. DuChateau. Summaries of the database reviews are provided below.

Materials and Construction

The HMA Mix Design Database was developed and is maintained by the Bureau of Materials Management at WisDOT. It was developed in a spreadsheet format for internal use by the Materials office. It contains the mix design approval from 1992 through 2004 and includes data corresponding to material selection and test results. In 2004, the system was replaced with the MTS, which now holds the data items for approved mix designs.

In 2000, WisDOT adopted SuperPave mix designs and therefore the format of the 2004 upgrade supports the inclusion of data elements corresponding to SuperPave mix design requirements. All the data from 2000 was moved forward to the MTS database, and the older information was left in the Mix Design Database.

- HMA Mix Design Database—In the HMA Mix Design Database, the Job Mix Formula (JMF) is a combined key of the Mix number associated with a Project Number. The Key is the Mix Number, which is a prefix indicating a description of the material, then a numeric sequence, followed by the year. The Project Number is the key used as a reference tied to the other information.

- MTS System—The MTS System holds SuperPave mix design data since 2000. The reference key is the Project ID defined by the State Highway Number, location, year of construction. Projects are also referenced to location by the intersection of major routes or within towns if they indicate location. Contractors have access to a duplicate database Material Information Tracking for their use to enter data. Field DOT offices use a similar duplicate database. Only the lab enters data into MTS.

Performance and Pavement Management

- PIF Database—The PIF database contains pavement condition data and it is a set of VSAM files that contain historical and current records of pavement performance. It can be treated as one large relational database. It can only be accessed within the DOT firewall. The PIF file uses a zone file format. Files are kept in an IBM style mainframe. SAS software is used to query the information from the PIF database. PIF consists of four parts.

  - Section Files—In the section files, the surface layer information is indexed by reference point. A reference point is a Highway number with a specified ‘from’ and ‘to’ crossing roadways. The sections are nominal 1-mi lengths. Information that is less than 1 mi is discarded by the system. Each 1-mi length is called a feature.

    The key index in the database is the Sequence Number. This number is a sequential value used to identify each unique section. Other information such as the Pavement Type, Surface Type, and the years of projects are stored in this file.

    The section file is referenced by using Reference Points. These reference points are consistent within the PIF database and the New Construction Database. These reference points are updated twice a year. The DOT at Hill Farms updates the MOTD information continually, so changes run behind in the Section File from the state Trunk Network Log.

On the data CD, the folder "Base Files" contains a dump of the PIF database. The file named "File.Key" contains the ID information for the file.

  - Distress Files for AC—The distress files for AC are based on the Wisconsin Pavement Distress Index (WPDI). The DOT is moving away from WPDI and moving to a PCI type of index.

  - Distress Files for PCC—The distress files for PCC are based on the Wisconsin Pavement Distress Index (WPDI). The DOT is moving away from WPDI and moving to a PCI type of index.

  - Historical Ride Data—These files contain historical ride index data.

- Layer and Base Database—The layer and base database is a collection of data that is pulled from other existing sources. This database contains information on pavement layer structure. Currently the Layer and Base database is under development. An older version of the database was in use, but has become expensive to update and is no longer updated. Modifications of the original design have resulted in many patches of functionality that created a great deal of difficulty to keep current. The new Layer and Base will provide a fresh start. It is currently being organized by a committee.

- New Construction Reports—This is a database made up of data gleaned from the PIF files and kept for organizational use. It is an internal ad-hoc database, not a supported DOT unit database. It contains all proposed projects. The data for this file are entered by a project manager, so it is considered to be accurate. This database was created to produce the "Ride Report" which is distributed in PDF format. Pavements included in this file are the state trunk network routes. This database contains project-level information as opposed to section-level information.

- Office All—Office All is a database created for a specific project in the past to synthesize life cycle cost analysis (LCCA) data and service life data. It is no longer available.

- Pavement Management Decision Support System—PMDSS was originally developed by ARA. It was recommended that future interviews must be made with David Fredericks of WISDOT to analyze this database.

Location/Spatial Referencing

Location Control Management (LCM)—LCM was developed to address the need for data integration across WISDOT databases and is maintained by WisDOT's IT Strategy & Architecture Section. LCM was a result of the Division of Highway's information strategy plan that aimed at developing an integrated information design representing all of the Division's business data and a strategy for automating systems which support this design. The strategy plan identified two key issues:

- Need for data integration which allows the query, analysis, and display of all data with spatial referencing.
- Need for access to historical data, which provides time-dependent information of the transportation network.

The data modeling, design, and stewardship of the LCM are governed by the departmental IT policies, which intend to reduce data duplication as well as serve the needs of multiple program areas. The program areas with dependencies on LCM databases are Division of Transportation Investment Management (DTIM), Division of Transportation System Development (DTSD), Department of Motor Vehicles (DMV), and Department of State Patrol (DSP) and other systems external to the DOT (see figure 1). LCM supports the following systems and tools within WisDOT as illustrated in figure 2, and they have been listed as referred to by LCM:

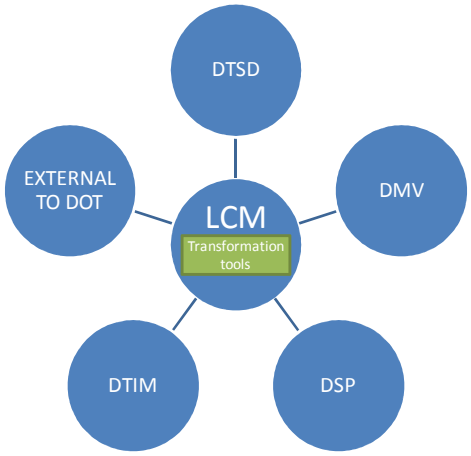

Figure 1. Business systems with dependencies on LCM Databases.

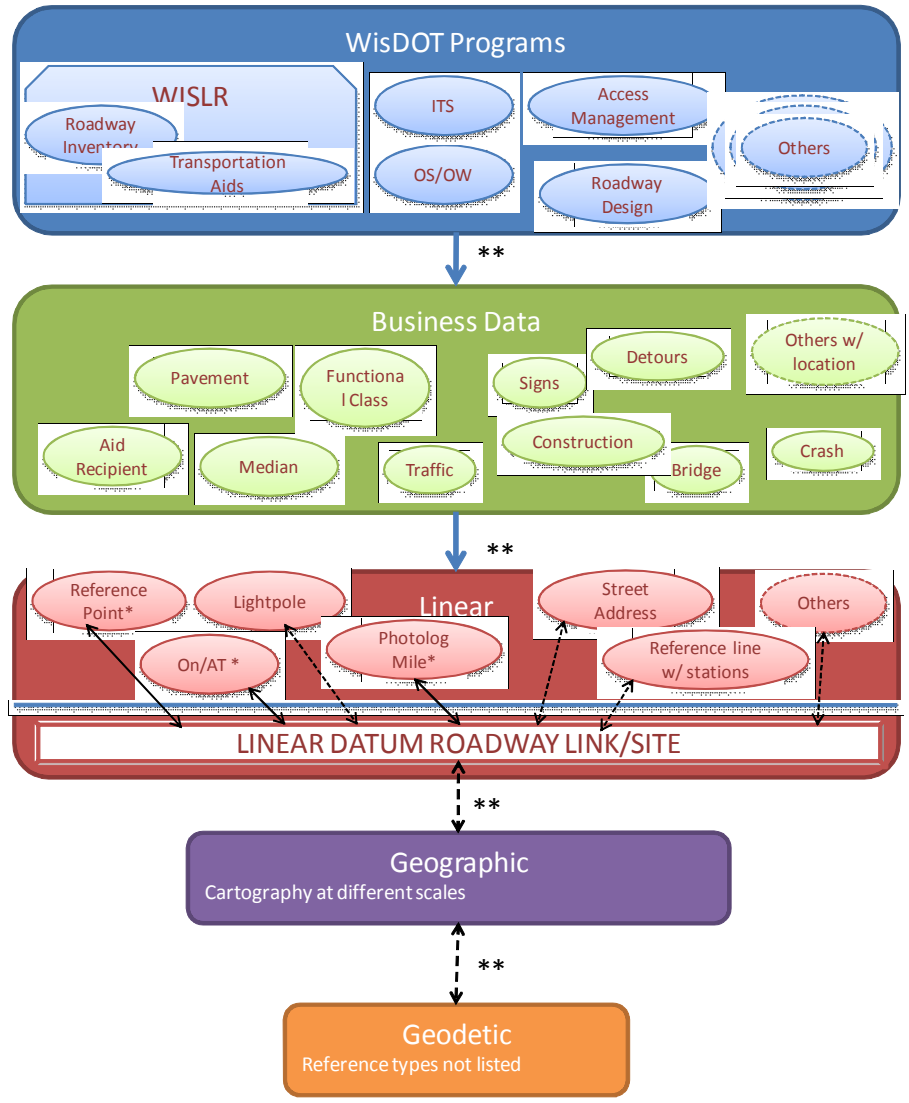

Figure 2. Systems supported by LCM and integration Scheme.

- WisDOT Programs, which include activities that support the mission of the department and the mandates.
- Business Data, which are attributes about entities that are of interest to WisDOT.
- Location Control for mapping of spatial information, which are divided into the following three areas:
  - Geodetic control, which defines locations on the surface of the earth, such as latitude-longitude-elevation, datum, coordinate systems and projections.
  - Geographic control, which defines areas on the surface of the earth, such as rivers, rails, highways, boundaries, soils, wetlands, etc. Geographic control (areas) is defined by geodetic control (specific locations).
  - Linear control, which define locations on a linear feature, such as mile posts, routes, reference points, addresses, etc. They are also not technology dependent (i.e. they do not need or rely on a specific software). Linear control is the heart of the LCM and all referencing methods are converted to the linear control.

Task 3—Identify and Map Logical Relationships in Databases

The Performance Database is indexed by the location in terms of Reference Points, not by the project. The actual location is not specific in MTS. Reference points for the specific project is is not directly accessible from the design database. WisDOT staff currently uses a visual GPS based database—DTD View, or van images— that has links to the specific location. The staff of the materials lab uses the HMA Mix Design spreadsheet to locate project numbers and then goes to other databases based on the project number. Users familiar with the program adopt a manual search to identify the location on based on Reference Points. This is the routine that the materials lab uses to find specific locations on the roadway.

Therefore it takes searches in 3 to 4 databases to track down performance data to a specific location. Also, there is no way to track down all the places where a mix design is used. The design used can only be found by referencing individual projects. Further, from a pavement forensic standpoint, there is no way currently to record possible problems for later evaluation. Currently this is done by anecdotal information. Customer complaints are collected, but no internal personnel can formally record predictions of performance based on unique factors known at the time of construction. It was also noted by the project team that no focus has been placed on data accuracy and truthfulness of data.

LCM provides a foundation to describe a location on the pavement network so that construction, materials, and performance data corresponding to the location can be accessed from their respective databases. Plans were made to access all data. Currently LCM supports Photo Log, Reference Point, and On/At data.

The Pavement Information File (PIF) has not been included in LCM. The PIF database has not been updated with all reference points using the latest reference point description. Therefore, there are gaps in some data and some duplication. There is also a problem with the PIF in that the PIF records locations inexactly when specifying where work is done within a section. Therefore PIF doesn't possess the automated tools for LCM in its current format.

The project team will explore the possibility of updating LCM transformation tools to integrate data across the construction, materials, and performance databases

Work Next Quarter:

In the upcoming quarter, the project team will complete the Task 2 database reviews and continue with the effort of identifying and mapping logical database relationships (Task 3). We will also identify database integration constraints (Task 4) and begin developing recommendations for various ways of linking WisDOT databases (Task 5).

Circumstances Affecting Progress/Budget:

The project is delayed by about 2.5 months due in part to difficulties in scheduling and conducting the database reviews. Although we hope to significantly reduce this delay in the coming months, a time extension may ultimately be needed.

Gantt Chart:

RESEARCH TASK	2007			2008												2009				EST. % COMP.
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	
1. Interview Researchers																				
			25	100																**100**
2. Review WisDOT Databases & Determine																				
WisDOT Database Linkage Needs				25	100															**80**
3. Identify & Map Logical Relationships in																				
Databases					10	50	100													**10**
4. Identify Database Integration Constraints																				
							25	100												
5. Suggest Revisions & Evaluate Methods																				
for Linking Databases									25	100										
6. Prioritize Database Integration																				
Recommendations										25	50	100								
7. Prepare Final Report & Technical Design																				
Document												10	40	80	80	80	100			
OVERALL % COMPLETION			1.9	12.7	29.3	34.1	42.0	47.5	50.2	61.0	63.9	72.7	81.8	93.9	93.9	93.9	100.0			**25.2**